Matthew Weingarten

CONTACT INFORMATION

Department of Geological Sciences
San Diego State University
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ResearchGate

RESEARCH INTERESTS

Fractured rock and fault hydrogeology; Integrated role fluids, faults and stress play in both natural and induced earthquakes; Water resources under a changing climate; Coupled geologic processes at the basin scale; Simulation-optimization techniques; Geostatistics; Numerical modeling

EDUCATION

University of Colorado-Boulder, Boulder, Colorado USA

Ph.D., Geology, December 2015

- Dissertation Title: *On the interaction between fluids and earthquakes in both natural and induced seismicity*
- Adviser: Professor Shemin Ge
- Area of Study: Hydrogeology, Induced Seismicity, Numerical Modeling

University of Wisconsin-Madison, Madison, Wisconsin USA

B.S., Geology and Geophysics, December 2009

- Minor in Environmental Studies
- Concentration: Hydrogeology

PROFESSIONAL EXPERIENCE

San Diego State University, San Diego, California USA — August 2018 - Present
Assistant Professor, Department of Geological Sciences

Stanford University, Stanford, California USA — February 2016 - June 2018
Postdoctoral Research Fellow, Stanford Center for Induced and Triggered Seismicity

University of Colorado-Boulder, Boulder, Colorado USA — June 2011 - February 2016
Graduate Research Scientist, Hydrogeology Laboratory

USGS John Wesley Powell Center, Fort Collins, Colorado USA — Jan. 2013 - Dec. 2015
Fellow, Center for Synthesis and Analysis

U.S. Geological Survey, Menlo Park, California USA — March 2010 - August 2010
Summer Internship, USGS/NAGT Summer Internship Program

TEACHING EXPERIENCE

San Diego State University, San Diego, California USA
Geology 551: Hydrogeology — Fall 2018
Geology 496: Water and Climate of the Desert Southwest — Spring 2019

Stanford University, Stanford, California USA
Poroelasticity Seminar, Stanford Geophysics Group — January 2017 - April 2017

University of Colorado-Boulder, Boulder, Colorado USA
Guest Lecturer, Geography 3402: Natural Hazards — August 2015
Teaching Assistant, Geology 3030: Hydrogeology — August 2014 - December 2014
Teaching Assistant, Geology 3950: Natural Hazards — January 2013 - May 2013
Teaching Assistant, Geology 2700: Field Geology — August 2010 - May 2011
Peer Mentoring Program Director, Geo 202: Structural Geology — Sept. 2009 - Dec. 2009

Awards and Honors

Invited Speaker, *American Geophysical Union*, Session: "Models and Experiments that couple flow and deformation in the shallow crust"(December 2016)

Best Graduate Student Paper Award, Geological Society of America South-Central Annual Meeting, Stillwater, Oklahoma (March 2015)

Harlen Erker Memorial Scholarship, Colorado Groundwater Association (July 2013)

Vail Global Energy Forum Scholarship, Renewable and Sustainable Energy Institute, Boulder, Colorado (March 2013)

Powell Center Fellowship, U.S. Geological Survey John Wesley Powell Center for Synthesis and Analysis (January 2013)

Outstanding Poster Award, University of Colorado Hydrologic Science Symposium (Spring 2012)

Shell Exploration and Production Graduate Research Award, Shell Exploration and Production (Spring 2012)

Peer Mentoring Appreciation Award, Structural Geology 202, Professor: Basal Tikoff (Summer 2010)

Summer Field Training Program Scholarship, U.S. Geological Survey-National Association of Geoscience Teachers Internship Program (March 2010)

Wasatch-Uinta Field Camp Scholarship, University of Wisconsin Field Camp (Summer 2009)

Peer-Reviewed Journal Publications

[1] **Weingarten, M.** and S. Ge (2014), Insights into water level response to seismic waves: A 24 year high-fidelity record of global seismicity at Devils Hole, *Geophysical Research Letters*, 41 (1), 74-80, doi:10.1002/2013GL058418.

[2] Keranen, K.M., **Weingarten, M.**, Abers, G.A., Bekins, B.A., and S. Ge (2014), Sharp increase in central Oklahoma seismicity since 2008 induced by massive wastewater injection, *Science*, 345 (6195), 448-451, doi:10.1126/science.1255802.

[3] **Weingarten, M.**, Ge, S., Godt, J.W., Bekins, B.A. and J.L. Rubinstein (2015), High-rate injection is associated with the increase in U.S. mid-continent seismicity, *Science*, 348 (6241), 1336-1340, doi:10.1126/science.aab1345.

[4] Lee, J.Y., **Weingarten, M.** and S. Ge (2016), Induced seismicity: The real threat from shale gas development and CO2 geologic storage? *Geosciences Journal*, 20 (1), 137-148, doi:10.1007/s12303-015-0030-5.

[5] Yeck, W.L., Sheehan, A.F., Benz, H. M., **M. Weingarten**, and J. Nakai (2016), Rapid response, monitoring, and mitigation of induced seismicity near Greeley, Colorado. *Seismological Research Letters*, 87 (4), 837-847, doi:10.1785/0220150275.

[6] Yeck, W.L., **Weingarten, M.**, Benz, H. M., McNamara, D. E., Herrmann, R. B., Rubinstein, J. L., and P.S. Earle (2016), Far-field pressurization likely caused one of the largest injection induced earthquakes by reactivating a large pre-existing basement fault structure. *Geophysical Research Letters*, 43 (10), 198âĂŞ207, doi:10.1002/2016GL070861.

[7] Wang, C. Y., Manga, M., Shirzaei, M., **Weingarten, M.**, Wang, L.P (2017), Induced Seismicity Affects Shallow Groundwater in Oklahoma. *Seismological Research Letters*, 88 (4), 1-7, doi:10.1785/0220170017.

[8] Goebel, T. H., **Weingarten, M.**, Chen, X., Haffaener, J., and Brodsky, E. E. (2017), The 2016 Mw5.1 Fairview, Oklahoma earthquakes: Evidence for long-range poroelastic triggering at >40 km from disposal wells. *Earth and Planetary Science Letters*, 472, 50-61. doi:10.1016/j.epsl.2017.05.011

[9] Nakai, J., **Weingarten, M.**, Sheehan, A.S., Bilek, S., Ge, S. (2017), A possible causative mechanism of Raton Basin, New Mexico and Colorado earthquakes using recent seismicity patterns and pore pressure modeling. *Journal of Geophysical Research-Solid Earth*, 122, 8051âĂŞ8065. doi:10.1002/2017JB014415

[10] Schoenball, M., Walsh, F. R., **Weingarten, M.**, Ellsworth, W. L., (2018), How faults wake up: the Guthrie-Langston, Oklahoma Earthquakes. *The Leading Edge - Special Issue on Induced Seismicity*, 37 (2), 100âĂŞ106. doi:https://doi.org/10.1190/tle37020100.1

[11] Keranen, K.M. and **Weingarten, M.** (2018), Induced Seismicity. *Annual Review of Earth and Planetary Science*, 46 doi:https://doi.org/10.1146/annurev-earth-082517-010054

[12] Levandowski, W.L., **Weingarten, M.**, Rall Walsh (2018), Geomechanical sensitivities of injection-induced earthquakes. *Geophysical Research Letters* doi:10.1029/2018GL077551

[13] Langenbruch, C., **Weingarten, M.** and M. D. Zoback (2018), Physics-based forecasting of man-made earthquake hazards in Oklahoma and Kansas. *Nature Communications* doi:10.1038/s41467-018-06167-4

[14] Scanlon, B.R., **Weingarten, M.**, Reedy, B., Murray, K.M. (2018), Managing BasinâĂŘScale Fluid Budgets to Reduce InjectionâĂŘInduced Seismicity from the Recent US Shale Oil Revolution. *Seismological Research Letters*

Publications in Preparation

[15] **Weingarten, M.**, S. M. Gorelick and M. D. Zoback (in prep for 2019), Stochastic simulation-optimization linking fluid flow and geomechanics: application to Pawnee M5.8 injection reduction plan.

[16] **Weingarten, M.**, Bekins, B.A., W. L. Yeck (in prep for 2019), Persistent injection-induced seismicity year after reduced injection rates. *Geophysical Research Letters*

Invited Talks

Invited Speaker, *Computational Sciences Research Center*, San Diego, CA. (December 2018)

Public Lecture, *Pecha Kucha*, San Diego, CA. (December 2018)

Invited Speaker, *University of New Mexico*, Albuquerque, NM. (October 2018)

Invited Speaker, *University of California-San Diego*, San Diego, CA. (October 2018)

Invited Speaker, *USGS Earthquake Science Center*, Menlo Park, CA. (May 2018)

Invited Speaker, *San Diego State University*, San Diego, California (November 2017)

Invited Speaker, *Southern Methodist University*, Dallas, Texas (February 2017)

Invited Speaker, *University of Minnesota*, Minneapolis, Minnesota (January 2017)

Invited Speaker, *American Geophysical Union Fall Meeting, San Francisco, California (December 2016)*

Invited Speaker, *University of California-Berkeley*, Berkeley, California (September 2016)

Invited Speaker, *Lawrence Livermore National Laboratory*, Livermore, California (June 2016)

Invited Speaker, *Chuncheon International Water Forum*, Chuncheon, Korea. (September 2015)

Invited Speaker, *USGS Earthquake Science Center*, Menlo Park, CA. (July 2015)

Invited Speaker, *USGS Crustal Geophysics Science Center*, Denver, CO. (February 2015)

Invited Speaker, *USGS Geologic Hazards Seminar Series*, Golden, CO. (January 2015)

Public Lecture, *Kiwanis Club of Boulder*, Boulder, CO. (January 2015)

Public Lecture, *University of Colorado Environmental Engineering Seminar*, Boulder, CO. (September 2014)

Public Lecture, *Denver Geophysical Society Microseismic Group*, Denver, CO. (June 2014)

Invited Speaker, *USGS Central US Earthquake Hazard Meeting*, Memphis, TN. (May 2014)

Invited Speaker, *National Academies Workshop*, Golden, CO. (April 2014)

PATENTS OR SOFTWARE LICENSING

Walsh, F. R., Zoback, M. D., Pais, D., Tyrell, T. and **Weingarten, M.** (2017), FSP 1.0: A Program for Probabilistic Assessment of Fault Slip Potential from Fluid Injection. *Stanford Office of Technology Licensing*, OTL License: 17-063.

CONFERENCE PRECEEDINGS

Weingarten, M. (2018) Persistent induced seismicity years after injection rate reductions, *AGU Fall Meeting*, Washington, D.C.

Weingarten, M., Gorelick, S. M., Zoback, M. D. (2017), Geostatistically Trained Simulation-Optimization Linking Fluid Flow and Geomechanics to Mitigate Injection Induced Seismicity in Areas with Known and Unknown Faults, *AGU Fall Meeting*, New Orleans, LA.

Langenbruch, C., **Weingarten, M.**, Zoback, M. D. (2017), Physics-based forecasting of earthquake hazards associated with induced seismicity in north-central Oklahoma and southern Kansas, *AGU Fall Meeting*, New Orleans, LA.

Reedy, B. C., Murray, K. E., **Weingarten, M.**, Scanlon, B. R. (2017), Assessing Produced Water Management Issues with Increasing U.S. Tight Oil Production (Invited), *AGU Fall Meeting*, New Orleans, LA.

Weingarten, M., Gorelick, S. M., Zoback, M. D. (2017), Stochastic simulation-optimization linking fluid flow and geomechanics for application to injection-induced seismicity, *SEG/SPE Workshop: 4th Injection-Induced Seismicity*, Dallas, TX.

Scanlon, B. R., Reedy, B. C., **Weingarten, M.**, Murray, K. E. (2017), Water Budgets of U.S. Tight Oil Plays: Implications for Induced Seismicity, *SEG/SPE Workshop: 4th Injection-Induced Seismicity*, Dallas, TX.

Scanlon, B. R., Reedy, B. C., **Weingarten, M.**, Murray, K. E. (2017), How can we manage produced water associated with unconventional oil to reduce potential hazards?, *GSA Annual Meeting*, Seattle, WA.

Levandowski, W., **Weingarten, M.**, Walsh, F.R. (2017), The of pre-injection pore fluid pressure in susceptibility to induced seismicity, *SSA Annual Meeting Abstracts*, Denver, CO.

Goebel, T. H., **Weingarten, M.**, Chen, X., Haffaener, J., and Brodsky, E. (2017), The 2016 Mw5.1 Fairview, Oklahoma earthquakes: Evidence for long-range poroelastic triggering at >40 km from disposal wells, *SSA Annual Meeting Abstracts*, Denver, CO.

Weingarten, M. and M.D. Zoback (2017), Are we past peak pressure in Oklahoma?, *Schatzalp Workshop on Induced Seismicity*, Davos, Switzerland.

Wang, C. Y., Manga, M., Shirzaei, M., and **Weingarten, M.** (2016), Induced Seismicity in Oklahoma Affects Shallow Groundwater, *AGU Fall Meeting Abstracts*, San Francisco, CA.

Weingarten, M. and M.D. Zoback (2016), Are we past peak pressure in Oklahoma? A hydrogeologic evaluation of reduced saltwater injection rates on induced seismicity, *AGU Fall Meeting Abstracts*, San Francisco, CA.

Yeck, W.L., **Weingarten, M.**, Benz, H. M., McNamara, D. E., Rubinstein, J. L., and Earle, P. S. (2016), Source characteristics of the Fairview, OK, earthquake sequence and its relationship to industrial activities, *AGU Fall Meeting Abstracts*, San Francisco, CA.

Weingarten, M., Goebel, T. H., Chen, X., Haffaener, J., and Brodsky, E. (2016), The 2016 Mw5.1 Fairview, Oklahoma earthquakes: Evidence for long-range poroelastic triggering at >40 km from disposal wells, *AGU Fall Meeting Abstracts*, San Francisco, CA.

Weingarten, M. and Ge S. (2015), Hydrogeologic Modeling Aimed at Optimizing Injection Well Operation in a Hypothetical Multi-Injection Well Reservoir: Implications for Induced Seismicity, *AGU Fall Meeting Abstracts*, San Francisco, CA.

Weingarten, M., Bekins, B.A., Hsieh, P.A., Rubinstein, J. L., Godt, J. W., and Ge, S. (2015), Fluid-pressure modeling of injection in the Raton Basin, Colorado-New Mexico: A case study of induced seismicity, *GSA Annual Meeting*, Baltimore, MD.

Llenos, A.L., Rubinstein, J. L., Ellsworth, W.L., Mueller, C.S., Michael, A.J., McGarr, A., Peterson, M., **Weingarten, M.**, and A.A. Holland (2015), Assessing Earthquake Hazards in the Anthropocene: Induced Seismicity in the Central and Eastern US, *International Workshop on Statistical Seismology*, Potsdam, Germany.

Weingarten, M., Ge, S., Bekins, B.A., Keranen, K.M., and Abers, G.A. (2015), Estimation of fluid pressure changes caused by injection wells near the Jones, Oklahoma earthquake swarm, *GSA-South Central Annual Meeting*, 47(1), Stillwater, OK.

Nakai, J., Sheehan, A.F., **Weingarten, M.**, and S. Bilek (2015), Potential induced seismicity in the Raton Basin, Colorado and New Mexico, 2008-2009, *SSA Fall Meeting Abstracts*, Pasadena, CA.

Llenos, A.L., Rubinstein, J. L., Ellsworth, W.L., Mueller, C.S., Michael, A.J., McGarr, A., Peterson, M., **Weingarten, M.**, and A.A. Holland (2015), Increased Earthquake Rates in the Central and Eastern US Portend Higher Earthquake Hazards, *SSA Fall Meeting Abstracts*, Pasadena, CA.

Yeck, W.L., Sheehan, A.F., **Weingarten, M.**, and J. Nakai (2014), The 2014 Weld County, Colorado, Earthquakes: A developing case of induced seismicity?, *AGU Fall Meeting Abstracts*, S51A-4393, San Francisco, CA.

Sheehan, A.F., Yeck, W.L., **Weingarten, M.**, Nakai, J., and S. Ge (2014), The 2014 Greeley, Colorado Earthquakes: Science, Industry, Regulation, and Media, *AGU Fall Meeting Abstracts*, PA23C-05, San Francisco, CA.

Weingarten, M., Ge, S., Godt, J.W., Bekins, B.A. and J.L. Rubinstein (2014), Is high-rate injection causing the increase in U.S. mid-continent seismicity?, *AGU Fall Meeting Abstracts*, S53E-06, San Francisco, CA.

Ge, S., **Weingarten, M.**, Person, M., and B.A. Bekins (2014), Connecting Wastewater Injection and Seismicity through Pore Pressure, *AGU Fall Meeting Abstracts*, U34A-06, San Francisco, CA.

Llenos, A.L., Rubinstein, J. L., Ellsworth, W.L., Mueller, C.S., Michael, A.J., McGarr, A., Peterson, M., **Weingarten, M.**, and A.A. Holland (2014), Increased Earthquake Rates in the Central and Eastern US Portend Higher Earthquake Hazards, *AGU Fall Meeting Abstracts*, U34A-02, San Francisco, CA.

Keranen, K.M., **Weingarten, M.**, Abers, G.A., Bekins, B.A., and S. Ge (2014), Triggered Earthquakes Far for the Wellbore: Fluid Pressure Migration and the 2008-2014 Jones Swarm, Central Oklahoma, *SSA Annual Meeting*, 85(2), Anchorage, AK.

Weingarten, M. and S. Ge (2013), Hydrogeologic controls on pore-pressure propagation from injection wells: implications for induced seismicity, *GSA Abstracts with Programs*, 159-2, Denver, CO.

Villaneda-Van Vloten, I., **Weingarten, M.**, and S. Ge (2012), Fluid Injection and Induced Seismicity: Two Ohio Case Studies, *AGU Fall Meeting Abstracts*, S34A-06, San Francisco, CA.

Weingarten, M. and S. Ge (2012), A case study of waste fluid injection and induced seismicity in the Raton Basin, Trinidad, CO, USA, *AGU Fall Meeting Abstracts*, S34A-05, San Francisco, CA.

Weingarten, M., S. Ge, and P.A. Cutillo (2011), A Frequency Domain Analysis of Seismically Induced Fluid-Pressure Changes in Devils Hole, Death Valley National Park, California-Nevada, *AGU Fall Meeting Abstracts*, H43E-1263, San Francisco, CA.

Weingarten, M. and P.A. Hsieh (2011), Simulating The Effect Of Matrix Diffusion In Fractured Porous Media With Dual Domain Mass Transfer: A Modeling Comparison, *University of Colorado Hydrologic Symposium*, Boulder, CO.

FIELD WORK

Alum Rock Springs, California (January 2017)

- Gathering water samples of fault-controlled springs to measure chemistry, temperature and discharge; collaboration with UC-Berkeley's Michael Manga

Enid, Oklahoma (May 2016)

- Pickup of Large-N (1500+) vertical-component seismometer array surrounding injection wells and deployed over tens of square miles; collaboration with USGS's Elizabeth Cochran and Sara Dougherty.

Greeley, Colorado (June 2014)

- Deployment of seismic network including landowner interaction/siting and setup of five seismometer stations surrounding an injection well; collaboration with CU-Boulder's William Yeck, Jenny Nakai and Anne Sheehan.

Raton Basin, Trinidad, Colorado (July 2013)

- Field surveying of outcrop thickness, outcrop samples collected for permeability analysis, fracture and fault orientation/aperture/spacing measurements; collaboration with Pioneer Natural Resources' Hal Macartney and U.S. Geological Survey's Phil Nelson.

Devils Hole, Death Valley National Park, Nevada (September 2012)

- Deployed new water level peizometers and helped reprogram CR-10 dataloggers to record high-frequency (1 Hz) water level fluctuations; collaboration with National Park Service's Paula Cutillo, Chris Gable and Jennifer Back.

Long Valley Caldera, Mammoth, California (May 2011)

- Measured vertical temperature gradients in boreholes, helped reprogram dataloggers to record rapid water level and water temperature changes, built monitoring station power supply, set up data telemetry; collaboration with U.S. Geological Survey's Shaul Hurwitz, Fred Murphy and Stuart Wilkinson.

TECHNICAL SKILLS

Proficient in Codes/Software:

Python
MATLAB
MODFLOW
MODELVIEWER
LATEX

Experience with Codes/Software:

FORTRAN-90
MODFLOW-SEAWAT
MT3DMS
TOUGH2
COULOMB 3.0

STUDENT ADVISING

Mariel Herzog
Investigation of possible induced seismicity due to wastewater disposal in the Delaware Basin, New Mexico-Texas, USA, *University of Colorado-Boulder Senior Thesis*, 2013–2014.

Isabel Villaneda-Van Vloten
Fluid Injection and Induced Seismicity: Two Ohio Case Studies, *UNAVCO Research Experience in Solid Earth Sciences Program*, 2012.

ACADEMIC SERVICE

Professional Memberships:
Geological Society of America (2009)
American Geophysical Union (2010)
Seismological Society of America (2014)

Reviewed Papers and Grants For:
National Science Foundation
Journal of Geophysical Research
Science Advances
Geophysical Research Letters
Earth and Planetary Science Letters
Seismological Research Letters
Bulletin of Seismological Society of America
Natural Hazards

Sessions Chaired At Major Conferences:
AGU 2015: "Induced and Triggered Earthquakes: Theory, Observations, Impact"
GSA 2016: "Injection-Induced Earthquakes: Geologic and Operational Constraints, Seismic Hazard, Mitigation and Societal Impact"
AGU 2016: "Induced Seismicity in the United States and Canada" : 50+ abstracts submitted
AGU 2017: "Induced Seismicity in the United States and Canada" : 50+ abstracts submitted
AGU 2018: "Induced Seismicity in the United States and Canada" : 40+ abstracts submitted

AGU 2017 Hydrology Section Outstanding Student Paper Award Committee

COMMUNITY SERVICE

Big Brothers Big Sisters of Colorado, Denver, Colorado, USA – Matched for 4+ years with little brother and meet regularly to play sports, learn crafts, or attend educational events.

Earth Explorers, Longmont, Colorado USA – Led a group of science-focused middle schoolers to develop an instructional video about the research we do in our hydrogeology lab.

Research Experience in Solid Earth Sciences for Students, Boulder, Colorado, USA – Designed and mentored an undergraduate student in a summer academic research project.

REFERENCES

Shemin Ge, Doctoral Advisor
Professor, Department of Geological Sciences
University of Colorado, Boulder
Phone: 303.492.8323
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Mark D. Zoback, Postdoctoral Advisor
Benjamin M. Page Professor, Department of Geophysics
Stanford University
Phone: 650.725.9295
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Steve M. Gorelick, Postdoctoral Advisor
Cyrus F. Tolman Professor, Department of Earth System Science
Stanford University
Phone: 650.725.2950
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Anne S. Sheehan, Doctoral Committee Member, Collaborator
Professor, CIRES and Department of Geological Sciences
University of Colorado, Boulder
Phone: 303.492.4597
Email: anne.sheehan@colorado.edu

POPULAR PRESS

UT-Austin News Center,Where Water Goes After Fracking is Tied to Earthquake Risk, *UT-Austin News Center*, November 1, 2018.

SSA News, Location of Wastewater Disposal Drives U.S. Induced Seismicity, October 31, 2018.

SDSU News Center, Researchers Identify Future Probability of Man-made Earthquakes, *SDSU News Center*, September 26, 2018.

Margolis, Jacob, How an earthquake in Alaska made a wave of water in Death Valley, *KPCC 89.3 Southern California Public Radio*, January 26th, 2018.

Dan Elliot Study: More Evidence Links Earthquakes to Energy Waste Wells , *The New York Times via The Associated Press*, October 25th, 2017.

CU-Boulder Press Raton Basin earthquakes linked to oil and gas fluid injections, *Phys.org*, October 24th, 2017.

Weingarten, M. Reddit AskScience AMA Series, *reddit.com*, June 19th, 2015.

Rosen, Julia, Huge study links wastewater injection wells to earthquakes, *Science Magazine News*, June 18, 2015.

Galchen, Rivka, "Weather Underground: The Arrival of Man-Made Earthquakes", *The New Yorker*, April 13th, 2015.

Oppel Jr., Richard A. and Michael Wines, "As Quakes Rattle Oklahoma, Fingers Point to Oil and Gas Industry", *New York Times*, April 3rd, 2015.

Branson-Potts, Hailey. "Did fracking fluid cause Greeley quake?", *9 News Denver*, June 3rd, 2014.

Paige-Ogburn, Stephanie. "Following Greeley Quake, Scientists Install Network To Look For More", *Community Radio Northern Colorado*, June 4th, 2014.

Hughes, Trevor. "Earthquakes near deep-earth wells raise concerns", *USA Today*, August 20th, 2014.

Branson-Potts, Hailey. "Study links Oklahoma earthquake swarm with fracking operations", *Los Angeles Times*, July 3rd, 2014.

David, Javier E. "'Small number' of gas drilling wells shaking up Oklahoma, study says", *CNBC*, July 3rd, 2014.

Fears, Darryl. "Firing fracking wastewater into the earth likely triggered Oklahoma's many earthquakes", *Washington Post*, July 3rd, 2014.

Hickey, Chuck. "CU-involved study: Oklahoma earthquakes likely linked to wastewater injection wells", *Fox 31 Denver*, July 3rd, 2014.

Mcclurg, Leslie. "CU Boulder study links Oklahoma earthquakes to wastewater injection wells", *Colorado Public Radio Interview + Story*, July 3rd, 2014.

Scott, Jim. "Oklahoma earthquake swarm linked to wastewater injection wells, says study involving CU-Boulder", *University of Colorado News Releases*, July 3rd, 2014.

Simpson, Kevin. "Spike in Oklahoma quakes likely caused by injection wells, study says", *Denver Post*, July 3rd, 2014.

Shauk, Zain. "Four Oil Industry Wells Tied to Oklahoma Earthquake Surge", *Bloomberg*, July 3rd, 2014.

Hand, Eric. "Injection wells blamed in Oklahoma earthquakes", *Science Magazine In Depth*, July 4th, 2014.

Passet, Charlie. "Researchers: Four Disposal Wells Likely Caused 20 percent of Central U.S. Quakes", *Natural Gas Intelligence*, July 7th, 2014.